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CONTENTS

OPTIMUM TIME OF DELAY FOR PARACHUTE OPENING

The opening of a parachute subjects the parachutist to a sudden and painful jerk, the severity of which depends approximately on the square of the speed at the time of opening. Openings at high speed may therefore result in immediate injury or tearing of the parachute.

As the result of calculations made by W. A. Wildhack of the Aeronautic Instruments Section, it has been shown theoretically that for horizontal launching, the velocity of a parachutist falling with parachute closed will pass through a minimum less than either the launching speed or the terminal speed. The terminal speed is that at which the air resistance equals the pull of gravity. It is reached after 10 to 12 seconds of fall, and is about 160 to 175 feet per second or 110 to 120 miles per hour at low altitudes. The best time to open the parachute with as little shock as possible is clearly the time of minimum speed.

In a report on this work, which will be published in the June number of the Journal of Aeronautical Sciences, formulas are derived relating the minimum velocity to the launching velocity and to the angle of the trajectory at which the minimum occurs. The time interval between the launching and the occurrence of minimum speed is determined from step-by-step computations for various launching velocities.

Charts are given for graphical determinations of the optimum time of delay, the velocity, and the distance fallen at any time before opening, for various launching velocities.

The formulas and charts are derived in general form, making them equally applicable to problems of landing material as well as personnel by parachute, given only the terminal velocity (or the mass and the drag at a given air speed). As one example, values obtained for an average parachutist (terminal velocity 160 feet per second) launched with a horizontal velocity of 160 feet per second, indicate that a minimum speed of 125 feet per second will be reached after 2.8 seconds, when the direction of falling makes an angle of 35° with the horizontal, and the vertical distance fallen is about 120 feet. The opening shock for the optimum delay would be approximately the square of the quotient of 125 divided by 160, or 61 percent of what it would be for immediate opening, or for opening delayed more than 12 seconds. Even for a launching velocity of 500 feet per second, the opening shock may be reduced to 80 percent of the value for terminal velocity by opening the parachute at the proper time—after 7 seconds for the average parachutist.

It is shown that the effect of altitude is to lengthen the optimum time of delay for a given indicated air speed at

[1] Published with approval of the Director of the Budget.

launching, the sea-level value having to be multiplied by the square root of the density ratio.

TEXTILE RESEARCH WAR COUNCIL

A Textile Research War Council was set up under the auspices of the Textile Research Institute and the Textile Foundation at a meeting of trade association executives in New York on April 7. Some twenty associations are affiliated with this project. The Council proposes to conduct and correlate research on textile problems arising out of the war effort. Approval of the Council has been expressed by the heads of the War Production Board, the National Inventors Council, the Bureau of Industrial Conservation, and by representatives of the military services. The Council should be able to make a valuable contribution. As member of the Executive Committee of the Textile Research Institute and chairman of the Technical Research Committee, W. D. Appel, chief of the Bureau's Textile Section, participated in the formation of the Council, and has attended subsequent meetings.

THE BETA-ANOMALY IN RUBBER

When Ruhemann and Simon measured the specific heat of rubber in 1928, they found three anomalies which they called the α, β, and γ. The existence of the α-anomaly, near $-70°$ C. has been confirmed by the later investigators. The γ-anomaly, found at temperatures between 15° and 30° C, was present only in rubber which could be shown by other means to be at least partially crystallized, and was said to be due to the melting of the crystals. There has been no question as to the correctness of this explanation.

The β-anomaly, however, which Ruhemann and Simon found near 0° C, has never been satisfactorily explained. Other observers have not been able to find irregularities in the specific heat or other properties of rubber in this region. Consequently, the existence and nature of the β-anomaly have remained a matter of doubt.

In a letter to the editor of the Journal of Chemical Physics, Lawrence A. Wood, of the Bureau's Rubber Section, points out that the results of Ruhemann and Simon can now be explained as a phenomenon of crystallization without the assumption of an anomaly characteristic of rubber in general.

Recent work at the Bureau has shown that the melting range of crystalline rubber is dependent on the temperature at which crystallization has taken place. Crystallization is most rapid near $-20°$ C, and it is probable that the experimental conditions of Ruhemann and Simon were such that the rubber was at a temperature near $-20°$ C for a sufficiently long period for crystallization to occur during their experiments. Rubber crystallized at such a temperature would be expected to melt near 0° C and to give rise to a peak in the specific heat curve like the one which Ruhemann and Simon named the β-anomaly.

The conclusion may then be drawn that the anomaly found near 0° C by Ruhemann and Simon represented merely the melting of crystals formed under the particular conditions of their experiments, and that this anomaly is not characteristic of rubber in general.

EFFECT OF ALTITUDE ON KNOCK RATING

Since the knock rating of motor gasolines was placed on a uniform basis by the adoption of the ASTM Motor Method in 1933, results obtained by laboratories located at different altitudes have shown systematic differences. Attempts were made to eliminate the variation by increasing the volumetric efficiency of engines operating at higher altitudes so as to maintain constant absolute compression pressure. Some improvement followed this measure, but deviations were still beyond experimental error.

Adoption of the 1939 CFR Research Method of knock rating raised the problem again. Field tests in which altered operating conditions were tried showed no great improvement. The Bureau was asked to carry out cooperative tests in its altitude chamber to determine appropriate conditions for rating by each test method at altitudes up to 7,000 feet. In the Journal of Research for June (RP1475), Donald B. Brooks describes and gives the results of these tests. The first series, made on one engine, indicated that a linear change in cylinder clearance volume with air pressure gave the desired results, the necessary rate of change being the same for all levels of octane number, but differing for the two test methods. Field tests verified the results. A second series, using three additional cylinder assemblies, substantiated the findings and developed the proper relations between cylinder clearance volume and octane number for both test methods. This information was verified and extended by field tests.

Equations were then derived to relate cylinder clearance volume to octane number and to altitude. From these relations, equations were deduced to relate octane number requirement to altitude. By comparison with field tests, these were found to be of general applicability.

RELIEF OF RESIDUAL STRESS IN STREAMLINE TIERODS

The residual stress in cold-worked streamline tierods was found to be so distributed as to act in the same direction as the superimposed service stresses. An investigation was made by Rolla E. Pollard and Fred M. Reinhart to determine whether or not the residual stress could be relieved by low temperature heat treatment without lowering the physical properties of the material.

The results, which will be published in the June Journal of Research (RP1477) show that about two-thirds of the residual stress in tierods of SAE 1050 steel could be relieved by heating 30 minutes at 600° F. without materially lowering the mechanical properties of the material.

Cold-worked austenitic stainless steel tierods also could be heated at temperatures high enough to relieve most of the residual stress without detriment to the mechanical properties. With material of straight 18–8 composition, however, heat treatment probably would be limited to temperatures below the precipitation range of chromium carbide. With the materials used, this temperature was found to be about 900° F. for a heating period of 30 minutes. It is possible that tierods containing additions of titanium, columbium, or molybdenum could be heated at higher temperatures, since the carbides of these elements would be precipitated in preference to chromium carbide.

A possible explanation of the residual stress distribution was noted in the X-bands contained in the cross-sections of cold-worked tierods. Microscopic examination and Vickers indentation tests indicated that the metal within the X-bands had been more severely cold-worked than in areas outside these bands.

PERFORATED COVER PLATES FOR STEEL COLUMNS

Built-up columns for bridge trusses are usually of box-type cross section, one side of which consists of lattice bracing or battens to allow access to the interior of the column for periodic inspection and painting. The bracing is usually assumed to contribute little to the strength and stiffness of the column.

It has been suggested that economies in the use of steel can be achieved by substituting perforated cover plates for bracing. Because very little information regarding such cover plates is available, the Bureau, in cooperation with the American Institute of Steel Construction, is investigating their compressive properties.

Two papers in the June number of the Journal of Research, RP1473, "Perforated Cover Plates for Steel Columns—Program and Test Methods," and RP1474, "Perforated Cover Plates for Steel Columns—Compressive Properties of Plates Having Ovaloid Perforations and a Width-to-Thickness Ratio of 40," by Ambrose H. Stang and Martin Greenspan, describe the investigation and give the results thus far obtained.

It was found that the perforated cover plates contribute to the strength, and especially to the stiffness, of columns, and that the factors of stress concentration, due to the presence of the holes, were not too high.

WEATHER RESISTANCE OF PORCELAIN ENAMEL ON IRON STRUCTURAL UNITS

The recent increase in the use of porcelain enamel on architectural units, and the diminished availability of zinc and tin for galvanized roofing and siding have accentuated the need of data on the weathering resistance of this type of protective coating.

In 1939 W. N. Harrison and D. G. Moore began a study on the weathering properties of 14 types and colors of enamel, including glossy, semimat, and mat finishes in both acid-resistant and nonacid-resistant compositions. This study, which is still in progress, involves a total of 864 one-foot-square panels and an equal number of 4- by 6-inch laboratory specimens. Installation of specimens in racks for exposure at four selected locations (Washington, D. C., St. Louis, Mo., Lakeland, Fla., and Atlantic City, N. J.) was completed in 1940.

At the end of the first year of weathering, all panels were inspected. As reported in RP1476 in the Journal of Research for June, the changes in the enamel surface were, for the most part, slight. In most cases, comparison with a storage panel of like composition was necessary to render any changes which had occurred visible to the naked eye. Even where the effects of weathering were readily visible, changes were con-

fined to the surface of the enamel only; no failure of the enamel coating to protect the underlying metal from rusting was discovered.

The first year inspection resulted in the following observations: (1) The glossy, acid-resistant compositions were in excellent condition at all locations. (2) The nonacid-resistant enamels, as a whole, showed evidence of weathering. (3) The mat enamels appeared to be unsuited for architectural use where appearance is important, because of fading and the difficulty of cleaning them. (4) Some of the colored nonacid-resistant enamels were slightly faded after one year because of tiny pits on the surface, caused probably by acid-forming gases such as carbon dioxide and sulfur dioxide in the atmosphere.

The pitting of the nonacid-resistant enamels was produced in the laboratory by subjecting them, while immersed in water, to carbon dioxide under slight pressure. Subsequent thorough drying was necessary to bring out the pits.

FADING RATE OF PAINTS

Ability to resist fading is a valued property of most paints and textiles. Two important evidences of fading—change of color and change of gloss—can now be measured by photoelectric methods developed within the past few years. In the June Journal of Research (RP1478), A. J. Eickhoff and R. S. Hunter describe a study in which photoelectric tristimulus measurements of color change and photoelectric measurements of specular-gloss change were used to follow the fading of several paint samples. These were exposed both outdoors and to two machine treatments (*A* and *B*) designed to weather the samples at an accelerated rate. Thus, it was possible to compare numerically the rates of artificial and natural fading of the paints. The data show: (1) The treatment used with apparatus *A* caused fading which averaged 20 times as fast as fading outdoors, but the speed-up factor varied from roughly 5 times for one paint to roughly 40 times for another; (2) the treatment used in conjunction with apparatus *B* caused fading which averaged 5 times as fast as fading outdoors, but the speed-up factor varied from roughly 3 times for one paint to roughly 20 times for another; and (3) for almost every paint tested, the factor relating the speed of fading from treatment in apparatus *A* to the speed outdoors was more nearly constant through the whole fading process than the corresponding factor for treatment in apparatus *B*.

Thus, treatment *A* not only faded paints faster, but it provided a preview of the course of fading which was usually a better representation of outdoor fading than that provided by treatment *B*. The data collected during the study are noteworthy chiefly for the methods they demonstrate. These should be valuable for future studies of the fading of materials and for the examination of methods for accelerated fading.

DETERMINATION OF CARBON AND HYDROGEN IN BONE BLACK AND OTHER CHARS

The ability of bone black and a variety of other materials of varying carbon content to adsorb large quantities of gases and to remove colored substances from solution indicates that carbon itself is the principal seat of the adsorptive activity. Among the carbon-containing substances available to industry, the content of carbon varies from approximately 5 percent in some bone blacks to 90 percent in some vegetable and other activated carbons. It is believed that two general factors determine the extent of adsorption or "activity", namely (1) the quantity of carbon present, and (2) the specific surface and physical state of the carbon surface. It is, therefore, important to have accurate data on the percentage of carbon in such materials as a necessary part in a fundamental study of the chemical and physical properties of bone black and analogous materials. Such data are presented in the June Journal of Research (RP1479) by Victor R. Dietz and Leland F. Gleysteen, Research Associates, working on a joint research project undertaken by the United States Cane Sugar Refiners and Bone Char Manufacturers and the Bureau.

The procedure for the special handling of such highly adsorptive substances is set forth with a description of the necessary apparatus. It is not possible to dry these materials to a constant weight in the conventional laboratory oven, nor is the use of a vacuum oven recommended because of dusting of the material. Instead, a simple procedure has been adopted to bring each sample for analysis to a constant weight by exposing it to water vapor in an exsiccator for 18 hours, and subsequent heating in a helium atmosphere at 105° C for 18 hours. Reproducible results are obtained by the combustion in oxygen of samples treated in this manner.

The samples are analyzed for carbon and hydrogen by complete combustion

in oxygen with the weighing of the resultant carbon dioxide and water. Auxiliary determinations are made of the carbonate in the ash from the combustion and of the carbonate and adsorbed carbon dioxide contained in the original material. The results are tabulated to give these separate contributions to the percentage of carbon.

A comparison was made with results for the same materials obtained by determining the loss upon ignition of the carbon residue from acid washing. The results indicate considerable deviation, which is attributed to volatile hydrogen, nitrogen, sulfur, and oxygen compounds which are not removed by acid washing. Although the data obtained by the combustion-in-oxygen method are to be preferred for use in research work and in other cases where accuracy is required, it should be pointed out that the data obtained by the loss-upon-ignition method are undoubtedly adequate for control purposes in the general routine of a sugar refinery laboratory where such data are of an empirical nature.

SPALLING OF FIREBRICK

The Refractories Section of the Bureau has been investigating the ASTM method of test for determining the thermal and structural spalling of fireclay brick. One of the requirements of this test is that when the brick are given the preliminary heat treatment at 1,600° C. for 24 hours, the pressure within the gas-heated furnace should be maintained between 0.2 and 0.6 inch of water.

In order to obtain information concerning the effect of gas pressure within the furnace on the spalling properties, several brands of firebrick were tested, using pressures of about 0.2, 0.4, and 0.6 inch of water. In the case of one brand of brick the spalling loss was 1.5 percent when the furnace pressure was maintained at 0.2 inch, but this loss was increased to 7.2 percent and 10.8 percent when the pressure was maintained at 0.4 and 0.6 inch, respectively. A second brand, which lost 15.6 percent in the spalling test when a pressure of 0.15 inch was maintained in the reheat furnace, showed no change in spalling resistance even though the pressure was increased to 0.5 inch. Another brand, which spalled 13.2 percent when reheated under a pressure of 0.15 inch, lost 27.4 percent when the furnace gas pressure was increased to 0.35 inch. Other brands tested showed similar trends.

CORROSION IN SOILS

Letter Circular LC689, "Corrosion in Soils," recently released, is a summary of data on a considerable number of phases of underground corrosion. The paper, which was prepared by Kirk H. Logan, chief of the Bureau's Underground Corrosion Section, is intended to save letter writing in answering oft-repeated questions regarding corrosion, many of which can not be answered briefly because of the number of factors involved.

The field of underground corrosion and its mitigation is covered briefly and nontechnically in most of its aspects, and numerous references are given in support of statements, or as supplementary reading. The paper is so arranged that any one with a general knowledge of corrosion phenomena need read only that section in which he is particularly interested. The paper discusses briefly the theory of corrosion, soil characteristics, causes of corrosion, soil tests, and methods of mitigating corrosion, including the selection of pipe materials, protective coatings, and cathodic protection. Underground corrosion is frequently the resultant of factors, some of which are characteristics of soils, while others arise from methods of installing pipe lines.

SIMPLIFIED PRACTICE RECOMMENDATION FOR BELL-BOTTOM SCREW JACKS

Simplified Practice Recommendation R97–42, Bell-Bottom Screw Jacks (Four-Way Head Type), comprises a list of stock sizes of screw jacks, as approved by the industry. This recommendation, which became effective on April 15, 1942, is a revision of the first edition, promulgated in 1930.

As originally issued, the recommendation established a simplified schedule of 38 stock sizes of bell-bottom screw jacks, which represented a reduction of approximately 50 percent from the 78 sizes which the industry had been manufacturing for general use.

The current revision further reduces the stock list to 27 sizes, or to approximately one-third of the number that were being offered prior to 1930. For each of the 27 sizes there is given diameter of screw, height of stand, and overall closed height.

This publication includes a brief history of the project, and lists the members of the standing committee and the

acceptors. Until the printed issue is available, free mimeographed copies may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

NATURAL LOGARITHMS OF THE DECIMAL NUMBERS

The latest volume in the series of mathematical tables prepared by the Works Projects Administration for the City of New York under the Bureau's sponsorship, is now ready for distribution. It is the fourth and last in a set of companion tables of natural logarithms and gives to 16 places the values of the logarithms of the decimal numbers from 5.0000 to 10.0000. The three other tables give, respectively: The values of the natural logarithms of the integers from 1 to 50,000; the values for the integers from 50,000 to 100,000; and the values for the decimal numbers from 0 to 5.

These tables are convenient for engineers and computers who have frequent use for natural logarithms and wish to obtain them with the least possible effort and time. The number of significant figures given in the argument (which exceeds all previous tables) is sufficient to avoid all but simple mental interpolation.

For the convenience of computers who may occasionally wish the values of logarithms and antilogarithms to greater accuracy than 16 significant figures, Table II is given. This makes possible the computation of logarithms and antilogarithms of any number to 24 significant figures, by repeated addition or subtraction.

The price of this new volume, designated MT12, is $2.00. This includes postage in the United States and in countries extending the franking privilege. Orders with remittance should be sent to the National Bureau of Standards, Washington, D. C.

NEW AND REVISED PUBLICATIONS ISSUED DURING MAY 1942

Journal of Research[2]

Journal of Research of the National Bureau of Standards, volume 28, number 5, May 1942 (RP1468 to RP1472, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Research Papers[2]

[Reprints from February and March 1942 Journal of Research]

RP 1452. Calculation of protein-anion affinity constants from acid titration data. Jacinto Steinhardt. Price 5 cents.

RP1455. An experimental study of beater practice in the manufacture of offset papers. Charles G. Weber, Merle B. Shaw, Martin N. Geib, and Martin J. O'Leary. Price 10 cents.

RP1456. Spectrophotometric determination of dysprosium, holmium, erbium, thulium, and ytterbium. Clement J. Rodden. Price 10 cents.

RP1457. Dielectric constant, power factor and conductivity of the system rubber-calcium carbonate. Arnold H. Scott and Archibald T. McPherson. Price 10 cents.

RP1458. Temperature estimates of the planet Mars, 1924 and 1926. W. W. Coblentz. Price 5 cents.

Simplified Practice Recommendations[2]

R185–42. Pipe fittings (gray cast iron, malleable iron, and brass or bronze). Price 10 cents.

Technical News Bulletin[2]

Technical News Bulletin 301, May 1942. Price 5 cents. Annual subscription 50 cents.

MIMEOGRAPHED MATERIAL

Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC683. Engineering mechanics: Publications by members of the staff of the National Bureau of Standards. (Supersedes LC595.)

LC686. Photoelectric cells; selenium cells; thermopiles. (Supersedes LC515.)

LC688. Temperature measurements: Publications by members of the staff of the National Bureau of Standards. (Supersedes LC469.)

LC691. List of commercial standards. (Supersedes LC676.)

[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents a year; Journal of Research, $3.50 a year (to addresses in the United States and its possessions and to countries extending the franking privilege; other countries, 70 cents and $4.50, respectively).

RECENT ARTICLES BY MEMBERS OF THE BUREAU'S STAFF PUBLISHED IN OUTSIDE JOURNALS[3]

Electrolytic behavior of ferrous and nonferrous metals in soil-corrosion circuits. I. A. Denison. Reprint 81–17, Electrochemical Soc. (3000 Broadway, New York, N. Y.) (April 20, 1942).

New American Standard includes batteries for hearing-aids. George W. Vinal. Industrial Standardization and Commercial Standards Mo. (29 West 39th St., New York, N. Y.) 13, 91 (April 1940).

[3] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

Review of "This chemical age—The miracle of man-made materials", by William Haynes. C. E. Waters. Chemical and Engineering News (1155 16th St., N. W., Washington, D. C.) 20, 483 (April 10, 1942).

Substitution of iron for nickel and copper in printing plates. V. A. Lamb. Electrotypers and Stereotypers Bul. (949 Leader Bldg., Cleveland, Ohio) 28, no. 4, 11 (April 1942).

The United States standards of measurements. Lyman J. Briggs, Engineering (18 and 20 Compton Road, Hayes, Middlesex, England) 153, 304 (April 17, 1942).

The Chesapeake Beach Railway. Hugh G. Boutell. Bul. 58, The Railway and Locomotive Historical Soc. (Baker Library, Harvard Business School, Boston, Mass.) 32 (May 1942).

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